AD-A060 229 NAVY UNDERWATER SOUND LAB NEW LONDON CONN F/G 9/2

DESCRIPTION OF SOFTWARE OF BIFI AUTOMATED DATA REDUCTION SYSTEM--ETC(U)

MAR 69 W G KANABIS

UNCLASSIFIED USL-TM-2211-91-69 NL

| OF |

AD A060229

END

DATE FILMED

12-78

DDC

COVIBI— PIS return 8/22

MOST Project

Code ______

Copy 42

AD A060229

DDC FILE COPY

(14) USL-TM-2211-91-69

USL Problem No.
9-A-409-00-00

SF 11 552 001-14054

-1-

U. S. NAVY UNDERWATER SOUND LABORATORY
FORT TRUMBULL, NEW LONDON, CONNECTICUT

(6) DESCRIPTION OF SOFTWARE OF BIFI AUTOMATED
DATA REDUCTION SYSTEM

(16) F11552

by

(10) William G./Kanabis

USL Technical Memorandum No. 2211-91-69

(11) 28 Mar[redacted]69

(17) SF11552001

2211-91-69

INTRODUCTION

With the expansion of testing conducted under project BIFI, it is clear that a high degree of automation is required in the data acquisition and reduction. When a Hewlett-Packard digital scanning system became available for use in October 1968 it became possible to automate to a high degree the daily propagation tests conducted over the BIFI range (described in reference a). This memorandum deals with the BIFI data acquision system located in Building 36, which is used in this testing and the two FORTRAN V programs, S1298 and S1357, which are used to reduce the data.

(9) Technical memo;

DATA ACQUISITION SYSTEM

(12) 30p.

The daily propagation tests are conducted over the BIFI range, shown in Figure 1. The range has a length of approximately 19 nautical miles and has a depth of about 120 feet through most of its extent. At Block Island, a projector tuned at 1702 Hz is bottom mounted at a 55 foot depth at point S. The receiving hydrophone is bottom mounted near Fishers Island in 155 feet of water at point H. The receiving station at Fishers Island is connected by means of data transmission lines to the Data Acquisition and Reduction Center in Building 36 at the

254 200

laboratory, where the signals are recorded and analyzed. A reference signal corresponding to the signal transmitted at Block Island is received at the Laboratory from the Block Island station by means of the Block Island telephone data line. Several frequency sensitive reed relays are connected in the receiving circuits at Fishers Island and these permit remote control and calibration of the receiving system from the Laboratory via the data transmission lines.

The receiving system in Building 36 is shown in Figure 2. The signal from the receiving hydrophone is received via the Fishers Island telephone data line, the CW signal is passed through either a 2 Hz or 0.1 Hz bandwidth filter prior to digitizing. The 2 Hz bandwidth filter is used in the winter, spring, and fall when the signal to noise ratio of the received signal is large and there is a large amount of frequency smear in the signal. The 0.1 Hz bandwidth filter will be used in the summer months when the signal to noise ratio of the received signal is smaller than in other seasons and due to a lack of dependence of the received signal upon the sea surface, thus, there is very little frequency smear. The envelope of the filtered signal is then sampled by the Hewlett-Packard scanner and digital voltmeter system and the digital value punched in IBM cards at a rate of approximately 3.5 samples per second. The entire receiving system has a dynamic range of better than 50 db. Over a range greater than 40 db the system is linear to at least .2 db per 10 db step. The system noise is low enough to permit measurement of signals of as low as -60 db relative to a 1 Dyne per square cm.

During the daily propagation tests, pulses 45 seconds long are transmitted from Block Island. During each one minute interval the signal is on for about 45 seconds and off for approximately 15 seconds. The recording sequence during the tests is shown in Figure 3. First the Block Island reference signal is recorded on IBM cards, prior to the first signal sequence being received at Fishers Island, for more than one minute or one cycle. Then the received signal at Fishers Island is recorded for 15 minutes on cards. Finally, a calibration of the system is performed. The calibration level is changed in equal increments and a same number of values are recorded at each level. The format of the data on the cards is four digits representing an integer followed by one digit which represents a negative exponent of the number 10 by which the first number is to be multiplied. Next the data is reduced by means of a USL FORTRAN V Program, S1298 on the UNIVAC 1108 computer.

PROGRAM S1298

USL Program S1298, written in FORTRAN V language, is designed to determine propagation loss and variance of signals received during the daily propagation runs. The data obtained is arranged as follows:

1. One input data card.

2. Calibration cards with higher calibration levels preceding lower levels.

3. The signal data cards in the order in which the data is taken, as described previously.

The format of the input data card and the quantities inputted are shown in Table 1. As seen in Figure 3 the first data recorded consists of the Block Island reference signal. This signal is used in program S1298 for two purposes. First, since a complete signal cycle is one minute in length from point A to B, we can compute the sampling rate per minute as the number of samples in the period, EMIN. The reference signal is also used to establish the time at which the signal is first transmitted from Block Island (point B). From the known propagation time (input parameter PROT which is 24 seconds for the present BIFI range) and the time after the beginning of the received pulse at which analysis is to commence (input parameter ENC which is 5 seconds for present analysis) the program determines point C and the signal is analyzed from point C to point D (DUR seconds long which is 30 seconds for the daily propagation runs). The ambient noise is analyzed commencing at point E. The distance from point B to point E is the input parameter RAMB (74 seconds in the present analysis). The analysis of ambient is conducted from point E to F (DURA seconds long which is 5 seconds in the present case). Analysis of succeeding pulses is accomplished by incrementing points C and E by one minute (EMIN). The number of pulses to be analyzed is given by INUM.

For each pulse analyzed, calculations are performed to measure the maximum, minimum and average values of voltages over the pulse, and the variance of the log of the voltage over the pulse. Also calculated is the average value of the voltage representing the background noise.

A number of calibration levels (input parameter NCAL is the number of levels) are analyzed. Each level has CAL measured values and the total number of calibration values analyzed equals ICAL. The calibration

equivalent level in db relative to 1 DYNE per square cm of the highest calibration level is given by EQUL and each level is decreased by ECDP db in each of the other calibration levels. The calibration equivalent loss of the highest calibration level is given by EQUV,

$$EQUV = N_s - EQUL$$

where N_s is the source level and EQUL is the calibration equivalent level, both in db relative to 1 DYNE per square cm. Each loss level is incremented by ECDP db in each of the other calibration levels. For each calibration level an average voltage level is calculated and an array SIGJ(JJ) is set up such that

$$SIGJ(JJ) = 20 \text{ Log } (\bar{V})$$

where $\bar{V}$ is an average voltage and JJ = (1...NCAL) where SIGJ(1) is the highest calibration and each succeeding value at the array represents a level with a calibration equivalent level of

$$EQUL - (JJ-1) * ECDP$$

or a calibration equivalent loss of

$$EQUV + (JJ-1) * ECDP$$

Having calculated the calibration levels and the maximum, minimum, and average of each pulse received level it is possible to calculate the propagation loss associated with the later three quantities. For a given level of one of these quantities propagation loss is calculated by either interpolating between or extrapolating beyond calibration levels associated with distinct calibration levels equivalent losses. Let x be the quantity whose associated propagation loss P_x is desired to be measured.

If x lies between two calibration levels then we interpolate between those values and

$$P_x = EQUL + ECDP * MM - (10.0 * LOG (X) - SIGJ (LL) * EDCP/$$

$$(SIGJ(MM) - SIGJ(LL))$$

where SIGJ (MM) and SIGJ (LL) are the values of SIGJ corresponding to calibration values above and below x respectively.

If x is greater than any calibration level then we extrapolate beyond the upper calibration value and

$$P_x = EQUL - (10.0 * LOG(X) - SIGJ(1)) * ECDP/ (SIGJ(1) - SIGJ(2))$$

If x is less than any calibration level then we extrapolate below the lowest calibration value and

$$P_x = EQUL + (NCAL-1)*ECDP-(10.0*LOG(x)-SIGJ(NCAL))*ECDP/SIGJ(NCAL-1)-SIGJ(NCAL)$$

If the number of calibration values NCAL, is one it is assumed that the recording system is linear between x and the calibration level and

$$P_x = EQUL-10.0*LOG(x)+SIGJ(1)$$

If x is the average background noise level, P_x is the propagation loss which would be measured for a signal with a level equal to the background noise. This quantity AMB2, is a measure of the maximum propagation loss which can be measured for a given level of background noise. The background noise level AMB is related to AMB2 by the relationship

$$AMB = - AMB2 + EQUL + EQUV$$

If the maximum or minimum level of signal plus noise falls below the background noise the quantity is set equal to 200 db propagation loss. If the average value of signal plus noise does not exceed the background noise then the average value of propagation loss is set equal to AMB2 and GTR is set equal to one. This effectively states that the average propagation loss is greater than AMB2.

For each pulse the maximum, minimum, and average values of propagation loss in db are printed out. Also printed out is the variance of the propagation loss in db over the pulse length as well as the ambient in db relative to 1 dyne per square cm, and AMB2 is db.

Also printed out are the average, of the number of pulses analyzed of the maximum, and average propagation losses and the average variance over a pulse. The variance of the maximum and average propagation loss measurements of the number of pulses analyzed is also printed out. These quantities are also punched on one output card, the format of which is shown in Table 2. Also punched out on this card are sea state, and

wind speed at the time of the tests and the value of GTR. This card can be used as data input to Program S1357.

There are two printed outputs in program S1298 which can be used as a check of the accuracy of the measurements taken. First the voltage level in db of each calibration level is printed out so that the linerity of the data acquisition and reduction system can be verified. The second check concerns the exponents of all input data. Due to the nature of the Hewlett Packard system the exponents of all data, taken with a given maximum input level setting, have the same value for the exponent. This value is inputted as the quantity EXP. If the value of the exponent of any data point differs from EXP, then the value of the exponent and its location in the data deck is printed out. Thus it is insured that a faulty alignment of data card columns in the data can be detected.

PROGRAM S1357

USL Program S1357, written in FORTRAN V language, is designed to measure averages of the propagation loss and variance data obtained from program S1298 and to plot these as well as theoretical predictions when applicable on the calcomp plotter in a form such that the graphs may be used in technical reports. The data is arranged as follows:

1. One input data card.

2. Input cards containing data of theoretical predictions.

3. Output cards from Program S1298.

4. Cards containing a list of sea states to be used as input parameters.

5. Cards containing a list of wind speeds to be used as input parameters.

The format of these cards is shown in Tables II to V.

Program S1357 is designed to generate as many as ten Calcomp plots from a set of data generated by many propagation tests whose data has been analyzed by means of program S1298.

A sample plot of one of the ten graphs which can be obtained is shown in Fig. 4. All values of propagation loss are plotted versus sea state and wind speed. Average values of propagation loss are also plotted against sea state and wind speed. The values are compared with those predicted by the COLOSSUS equations. In the second set of curves standard deviations of each average value are plotted. A special symbol is generated for data whose value for GRT is one. This symbol indicates that the value plotted is an indication of a minimum propagation loss which could be measured.

Average propagation loss determined by measuring an average pressure level in a single pulse is compared to that determined by measuring a maximum pressure level in a pulse in two graphs. Both are plotted versus sea state and wind speed.

The average of the variances of propagation loss measured over individual pulses is plotted versus sea state and wind speed. Values for which GTR equals one are not plotted.

The variance between pulses of measured propagation loss in a given run determined by measuring an average pressure level in a single pulse is compared with that of propagation loss determined by measuring maximum pressure level in a pulse. This is done in two graphs where both are plotted versus sea state and wind speed. Values for which GTR equals one are not plotted.

If ISZ (see Table III) is set equal to one, only the four graphs in which propagation loss is determined from average pressure levels are plotted. If ISZ equals zero, all ten graphs are plotted. If ISEA is set equal to one, labels pertinent to "winter data" (small positive to weak negative velocity gradients) are put on the graphs while an ISEA of zero corresponds to "summer data" (weak negative to large negative velocity gradients).

Tables are also printed out which list sea state or wind speed, average propagation loss, number of values at the particular wind speed or sea state considered and standard deviation of these values.

SUMMARY

The current BIFI system of data acquisition and reduction of the daily propagation tests brings a high degree of automation to the processing of the acoustic data. In the future it is planned to transmit signals at least in three different frequencies and to receive these signals with hydrophone arrays located at Fishers Island and Watch Hill and connected via telephone data links to the data reduction laboratory at USL. It is planned to purchase Kennedy 1406 digital tape recorder to replace the IBM card punch. This will increase the sampling rate attainable from about 35 samples per second to 100 samples per second. Since the Hewlett Packard System can scan through a maximum of 100 channels with small modifications to the receiving systems and programs one will be able to process data, in a manner similar to that described in this report, at many frequencies and many receiving hydrophones.

William G Kanabis
WILLIAM G. KANABIS

REFERENCES

a. Schumacher, W.R. "Shallow Water Acoustic Studies; information concerning; USL Technical Memorandum No. 2211-18-68

FORMAT (2I5, F5.1, 6F5.0, F5.1, 2I5, 2F5.0, F5.1, F5.0)

INPUT PARAMETER	COLUMNS	
INUM	1-5	Number of pulses to be analyzed
ICAL	6-10	Total number of Cal values to be read in
EQUV	11-15	Cal equivalent loss of first (highest value) calibration (source level - cal equivalent level (DB))
PROJ	16-20	Propagation time in sec between source and receiver
ENC	21-25	Time after leading edge of received pulse at which summation should begin (SEC)
DUR	26-30	Length of signal sample to be analyzed (sec)
CAL	31-35	Number of values in individual calibrations
RAMB	36-40	Time after leading edge of transmitted pulse at which noise should be sampled (sec)
DURA	41-45	Length of ambient desired to analyze
EQUL	46-50	Cal equivalent level of first (highest) calibration level (db)
ISIG	51-55	Total number of values of signal
NCAL	56-60	Number of calibration levels
ECDP	61-65	Increment in levels of calibrations (db)
SS	66-70	Sea state
WSPD	71-75	Wind speed (mph)
EXP	76-80	Value of exponent in all data

TABLE I

INPUT CARD FOR PROGRAM S1298

FORMAT 80 (Flo.5)

PARAMETER	COLUMNS	
SS	1-10	Sea State
WSPD	11-20	Wind Speed
AVE	21-30	Average propagation loss measured over pulses
EMAX2	31-40	Average of maximum propagation loss measured
AVAR	41-50	Average variances over pulses
VMAX	51-60	Variance of maximum propagation loss between pulses
VAV	61-70	Variance of average propagation loss between pulses
GTR	71-80	1=propagation loss greater than AVE
		0=propagation loss equal to AVE

TABLE II
OUTPUT CARD FROM PROGRAM S1298

FORMAT 3I5, F5.0, 3I5

INPUT PARAMETER	COLUMN	
NC	1-5	Number of prediction values
ND	6-10	Number of data cards from program S1298
NS	11-15	Number of sea states inclusive between lower and highest values in increments 0, 0.5, 1,2, 3 ......
EST	16-20	Propagation loss value at origin of graphs
NW	21-25	Number of wind speeds inclusive between lowest and highest values in increments 0, 2.5, 5, 10, 15 ....
ISZ	26-30	Number of graphs 0 = 10 1 = 4
ISEA	31-35	Season data was taken 0 = summer; 1 = winter

TABLE III
INPUT CARD PROGRAM S1357

FORMAT 5F10.5

NC = NUMBER OF CARDS

INPUT PARAMETER	COLUMNS	
CSS	1-10	Sea State
CWS	11-20	Wind Speed
COLU	21-30	Upper Propagation loss prediction
COLL	31-40	Lower Propagation loss prediction
CW2	41-50	Wind Speed (2)

TABLE IV
INPUT CARDS WITH THEORETICAL PREDICTIONS
PROGRAM S1357

NS = NUMBER OF SEA STATE VALUES

NW = NUMBER OF WIND SPEED VALUES

FORMAT 8F10.5

INPUT PARAMETERS	COLUMNS	
Z or ZZ	1-10	ZZ is wind speed (mph)
	11-20	They are inputed in ascending order of magnitude
	21-30	
	31-40	
	41-50	
	51-60	
	61-70	
	71-80	

TABLE V

INPUT CARD LISTING SEA STATES OR WIND SPEEDS
PROGRAM S1357

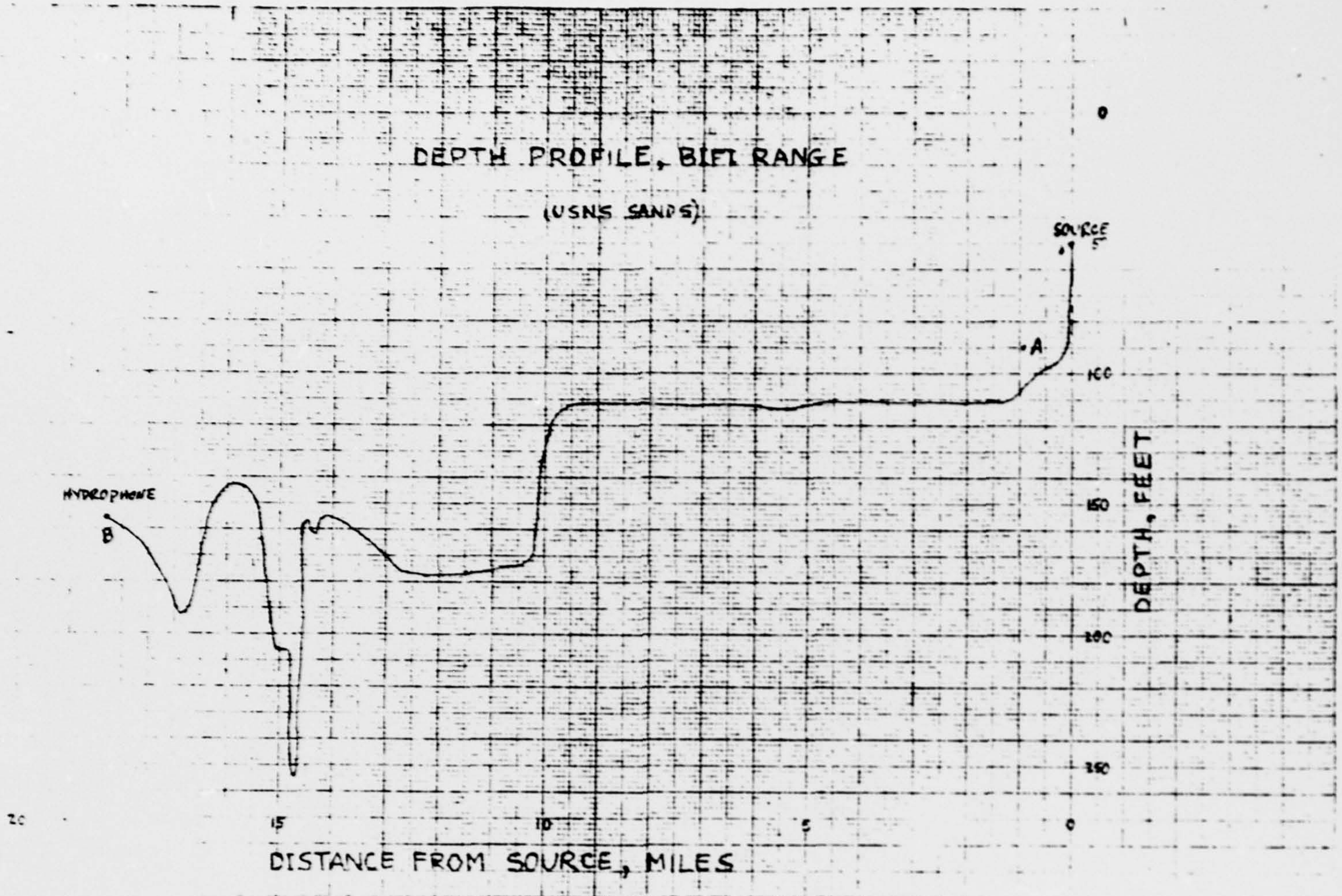
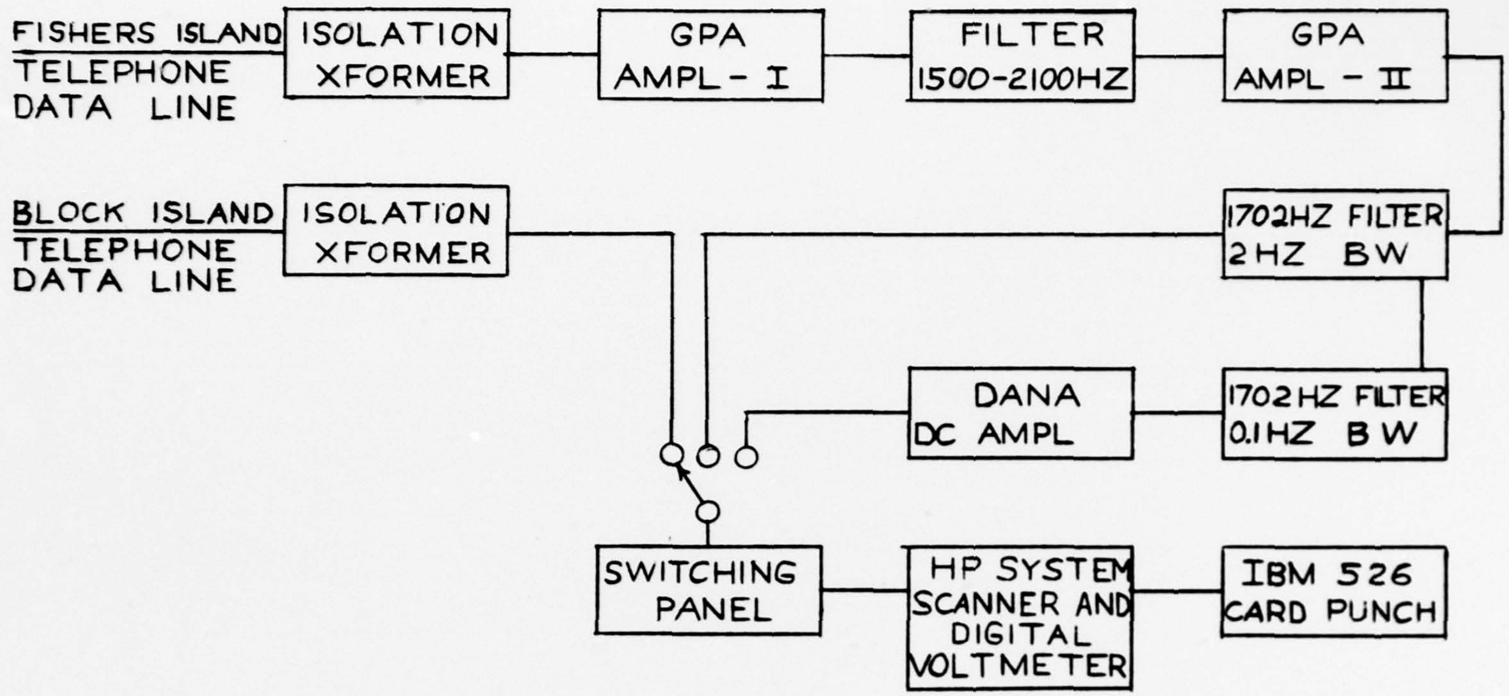


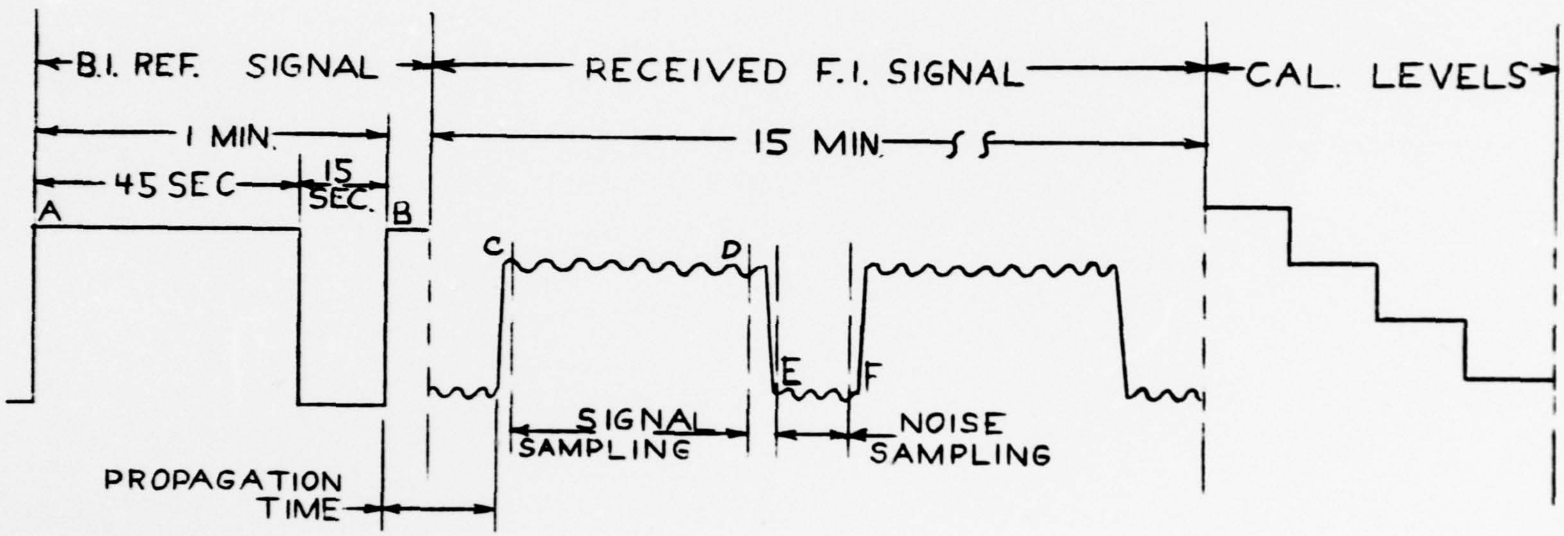
Figure 1

USL Tech Memo
No. 2211-91-69



BIFI RECEIVING SYSTEM—BLDG. 36

FIG. 2
USL Tech Memo
No. 2211-91-69



RECORDING SEQUENCE

FIG. 3
USL Tech Memo
No. 2211-91-69

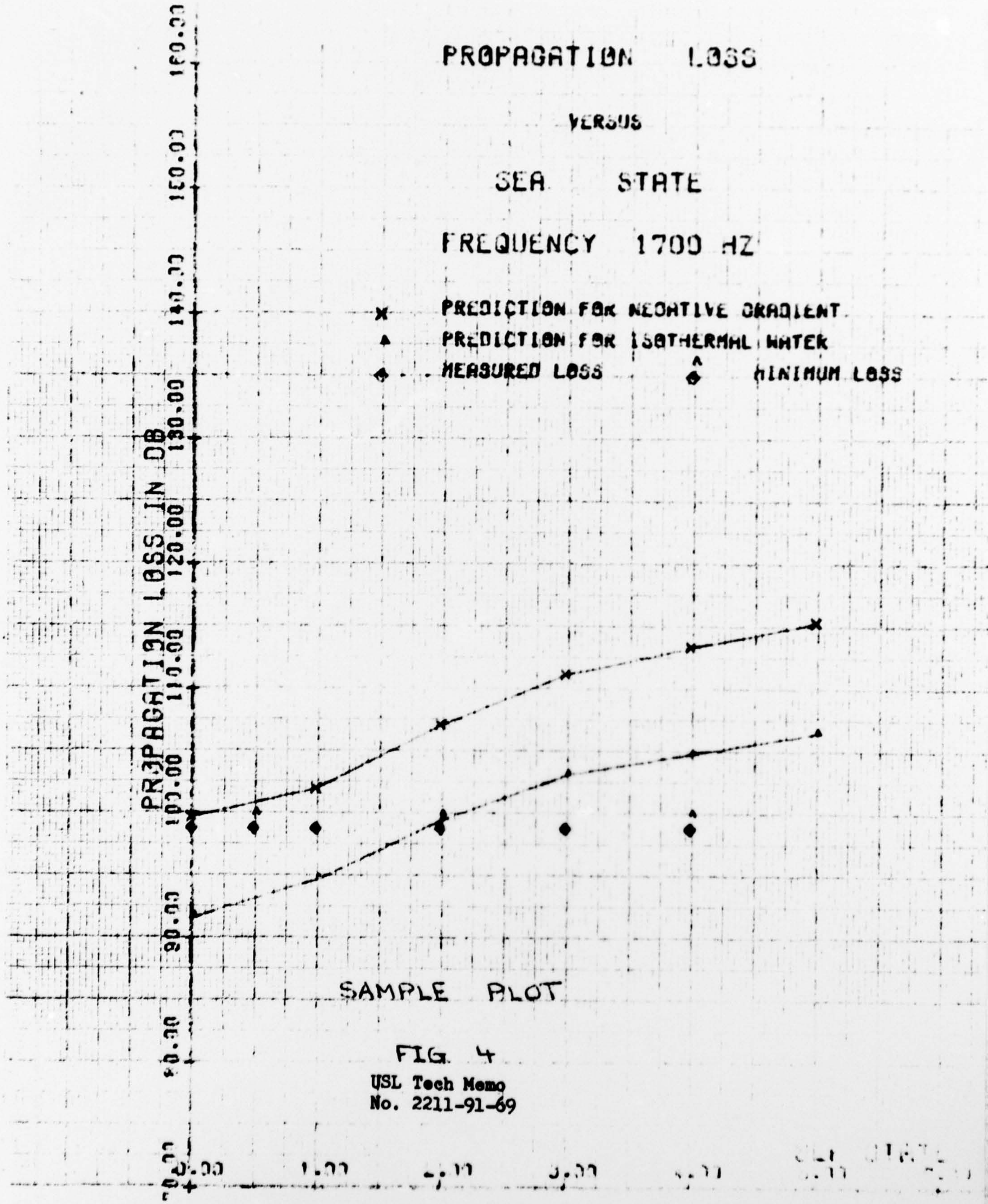


FIG. 4

USL Tech Memo
No. 2211-91-69

```
 INTENSITY CALCULATION FOR LONG PULSES     S12918
 DIMENSION   SIG (  10000) , SIGC(1000) , ESIG(  10000),ESIGC(1000)
1    ,F(10000)                  ,  SIGJ(100)
 WRITE  (4,19)
19 FORMAT(106H MAX, MIN, AVER ARE PROP LOSS IN DB, AMB IN DB REL DYNE
 1 PER SQUARE CM, VAR IS VARIANCE OF LOG PRES SQUARED)
 READ (3,1) INUM,ICAL,EQUV,PROT,ENC,DUR,CAL,RAMB,DURA,EQUL,ISIG
1  , NCAL  ,  ECUP  ,  SS  ,  WSPD , EXP
 WRITE(4,1) INUM,ICAL,EQUV,PROT,ENC,DUR,CAL,RAMB,DURA,EQUL,ISIG
1  , NCAL  ,  ECUP  ,  SS  ,  WSPD ,  EXP
1 FORMAT(2I5,F5.1,6F5.0,F5.1,2I5,2F5.0,F5.1,F5.0)
 READ (3,2) ( SIGC(J) , ESIGC(J), J=1,ICAL )
2 FORMAT (16(F4.0,F1.0)  )
 READ (3,2) ( SIG(J), ESIG(J) , J= 1, ISIG )
 DO  70  J =  1,  ICAL
 IF  (ESIGC(J)  -  3.0  )  72,70,72
72 WRITE (4,75)  J , ESIGC(J)
75 FORMAT  ( I5,  F5.0 )
70  CONTINUE
 DO  71   J  =  1,  ISIG
 IF ( ESIG(J)  -  EXP  )  73,71,7
73 WRITE (4,76)  J , ESIG(J)
76 FORMAT  (5X, I5,  F5.0  )
71  CONTINUE
 DO  60  JJ  =  1 , NCAL
60 SIGJ(JJ)  =  0.0
 ICAL  =   ICAL/NCAL
 DO  61  JJ  = 1,  NCAL
 DO 3  J = 1, ICAL
 JL  =   J  +  ICAL*(JJ-1)
3 SIGJ(JJ)=SIGJ(JJ)+(SIGC(JL)/10.**ESIGC(JL))**2.0
 SIGJ(JJ)  =  10.0*ALOG10(SIGJ(JJ)/CAL)
15 FORMAT(F10.5)
61 WRITE(4,15)SIGJ(JJ)
 DO 4  J= 1,300
 F(J+1)  =  SIG(J+1) / 10.0** ESIG(J+1)
30 FORMAT  (F10.5)
 F(J)  =   SIG(J)/10.0** ESIG(J)
 IF (   F(J+1) -F(J) -.2  )  4,4,5
4 CONTINUE
5 ISTR= J + 1
 DO 6  K= 1,300
 J  =  ISTR  +  K
 F(J)  =   SIG(J)/10.0** ESIG(J)
 F(J+1)  =  SIG(J+1) / 10.0** ESIG(J+1)
 IF (   F(      J)  -    F(     J +1)- .2 )     6,6,7
6 CONTINUE
7 ISTP =       + J
 DO 8  K=1, 300
 J  =  ISTP  +  K
 F(J)  =   SIG(J)/10.0** ESIG(J)
 F(J+1)  =  SIG(J+1) / 10.0** ESIG(J+1)
 IF (   F(      J +1)-      F(      J)-.2) 8,8,9
8 CONTINUE
9 ISTB =      +J +1
 WRITE(4,16) ISTR ,ISTP ,ISTB
16 FORMAT(3I10)
 IMIN = ISTB - ISTR
```

THIS PAGE IS BEST QUALITY PRACTICABLE FROM COPY FURNISHED TO DDC

```
      EMIN = IMIN
      ISSG =  EMIN*(PROT + ENC)/60.0
      IRAMB =    RAMB*EMIN/60.0
      IDUR =  DUR*EMIN/60.0
      IDURA =    DURA*EMIN/60.0
      WRITE (4,17) IMIN , ISSG ,IDUR ,IRAMB ,IDURA
   17 FORMAT(5I10)
      WRITE (4,18)
   18 FORMAT (50H1  MAX        MIN         AVER        VAR         AMB     )
      AVE = 0.0
      EMAX2  = 0.0
      AVAR  = 0.0
      AVAM  =  0.0
      VMAX  =  0.0
      VAV  =  0.0
      DO 10    K=1,INUM
      EMAX  =0.0
      EMIN  =1000000.0
      TOTS =0.0
      TOT  =0.0
      TO2  = 0
      TOTA =0.0
      DO 11    L=1, IDUR
      M = L   +(K-1)*IMIN
      J  =  ISTB  +  ISSG  +  M
      F(J)  =    SIG(J)/10.0** ESIG(J)
      IF (    F(J)**2.0            .GT.EMAX)EMAX = (   F(J                   ))**2.0
      IF (    F(J)**2.0            .LT.EMIN)EMIN = (   F(J                   ))**2.0
      TOT = TOT + (  F(J                   ))**2.0
      TO2  =  TO2  + 20.0*ALOG10(F(J))
      TOTS= TOTS+   (20.0*ALOG10(F(J)))**2.0
   11 CONTINUE
      DO 12    M=1, IDURA
      N= M +(K-1)*IMIN
      J  =  ISTB  + IRAMB  +  N
      F(J)  =    SIG(J)/10.0** ESIG(J)
      TOTA= TOTA+ (  F(J                    ))**2.0
   12 CONTINUE
      DUR=IDUR
      DURA= IDURA
      ECAL  =  NCAL  -  1
      IF  ( NCAL - 1 )    97,97,98
   97 AMB2  =    EGUL  -  10.0*ALOG10(TOTA/DURA)  +  SIGJ(1)
      GO  TO  36
   98 DO 39 LL = 1,NCAL
      IF (10.0*ALOG10(TOTA/DURA).GT.SIGJ(LL)) GO TO 45
   39 CONTINUE
      AMB2 = EGUL +ECAL*ECDP-(10.0*ALOG10(TOTA/DURA          )-SIGJ(NCAL))
     1*ECDP/(SIGJ(NCAL-1) - SIGJ(NCAL) )
      GO TO 36
   45 DO 42 MM = NCAL ,1,-1
      IF (10.0*ALOG10(TOTA/DURA).LT.SIGJ(MM)) GO TO 48
   42 CONTINUE
      AMB2 = EGUL -(10.0*ALOG10(TOTA/DURA        ) -SIGJ(1)))*ECDP/(SIGJ(1)
     1 - SIGJ(2))
      GO TO 36
   48 AMB2  =  EGUL  +  ECDP*MM  - (10.0*ALOG10(TOTA/DURA        ) -SIGJ(LL
     1)) * ECDP/  (SIGJ(MM)  -  SIGJ(LL))
```

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

```
36 IF  (EMAX - TOTA/DURA )  20,20,21
20 EMAX  = +200.0
   GO  TO  22
21 IF  ( NCAL - 1 )   91,91,92
91 EMAX= EQUL - 10.0*ALOG10(EMAX- TOTA/DURA ) + SIGJ(1)
   GO  TO  22
92 DO 32 LL = 1,NCAL
   IF (10.0*ALOG10(EMAX).GT.SIGJ(LL))  GO TO 33
32 CONTINUE
   EMAX = EQUL +ECAL*ECDP-(10.0*ALOG10(EMAX-TOTA/DURA)-SIGJ(NCAL))*
  1ECDP/(SIGJ(NCAL -1) - SIGJ(NCAL) )
   GO TO 22
33 DO 34 MM = NCAL ,1,-1
   IF (10.0*ALOG10(EMAX).LT.SIGJ(MM)) GO TO 35
34 CONTINUE
   EMAX = EQUL -(10.0*ALOG10(EMAX -TOTA/DURA) -SIGJ(1))*ECDP/(SIGJ(1)
  1 - SIGJ(2))
   GO TO 22
35 EMAX  =  EQUL  +  ECDP*MM  - (10.0*ALOG10(EMAX-TOTA/DURA) -SIGJ(LL
  1))*  ECDP/  (SIGJ(MM)  -  SIGJ(LL))
22 IF (EMIN -  TOTA/DURA ) 23,23,24
23 EMIN  =  +200.0
   GO  TO  25
24 IF  ( NCAL - 1 )   93,93,94
93 EMIN= EQUL - 10.0*ALOG10(EMIN- TOTA/DURA ) + SIGJ(1)
   GO  TO  25
94 DO 37 LL = 1,NCAL
   IF (10.0*ALOG10(EMIN).GT.SIGJ(LL))  GO TO 43
37 CONTINUE
   EMIN = EQUL +ECAL*ECDP-(10.0*ALOG10(EMIN-TOTA/DURA)-SIGJ(NCAL))*
  1ECDP/(SIGJ(NCAL -1) - SIGJ(NCAL) )
   GO TO 25
43 DO 40 MM = NCAL ,1,-1
   IF (10.0*ALOG10(EMIN).LT.SIGJ(MM)) GO TO 46
40 CONTINUE
   EMIN = EQUL -(10.0*ALOG10(EMIN -TOTA/DURA) -SIGJ(1))*ECDP/(SIGJ(1)
  1 - SIGJ(2))
   GO TO 25
46 EMIN  =  EQUL  +  ECDP*MM  - (10.0*ALOG10(EMIN-TOTA/DURA) -SIGJ(LL
  1))*  ECDP/  (SIGJ(MM)  -  SIGJ(LL))
25 IF  (TOT/DUR  -  TOTA/DURA )  26,26,27
26 AVER=  AMB2
   GTR  =  1.0
   GO  TO  28
27 IF  ( NCAL - 1 )   95,95,96
95 AVER= EQUL - 10.0*ALOG10(TOT/DUR - TOTA/DURA) +SIGJ(1)
   GO  TO  28
96 DO 38 LL = 1,NCAL
   IF (10.0*ALOG10(TOT/DUR).GT.SIGJ(LL)) GO TO 44
38 CONTINUE
   AVER = EQUL +ECAL*ECDP-(10.0*ALOG10(TOT/DUR-TOTA/DURA)-SIGJ(NCAL))
  1*ECDP/(SIGJ(NCAL-1) - SIGJ(NCAL) )
   GO TO 28
44 DO 41 MM = NCAL ,1,-1
   IF (10.0*ALOG10(TOT/DUR).LT.SIGJ(MM)) GO TO 47
41 CONTINUE
   AVER = EQUL -(10.0*ALOG10(TOT/DUR-TOTA/DURA)-SIGJ(1))*ECDP/
  1(SIGJ(1) - SIGJ(2) )
```

```
   GO TO 28
47 AVER  =  EQUL  +  ECDP*MM-(10.0*ALOG10(TOT/DUR-TOTA/DURA) -SIGJ(LL
  1))*  ECDP/  (SIGJ(MM)  -  SIGJ(LL))
28 VAR = TOTS/DUR  - (TO2/DUR)**2.0
   AMB =-AMB2 +EQUL +EQUV
   AVE = AVE + AVER
   AVAM   =  AVAM   +  AMB2
   AVAR   =  AVAR   +  VAR
   EMAX2 = EMAX2  +  EMAX
   VMAX   =  VMAX   +  EMAX**2.0
   VAV  =  VAV  +  AVER**2.0
   WRITE (4,13)EMAX,EMIN ,AVER, VAR, AMB,AMB2
13 FORMAT (6(F10.5))
10 CONTINUE
   AVE   =  AVE / FLOAT(INUM)
   AVAR  =  AVAR/ FLOAT(INUM)
   AVAM   =   AVAM/ FLOAT(INUM)
   EMAX2  =  EMAX2 / FLOAT(INUM)
   VMAX   =  VMAX/FLOAT(INUM)   -  EMAX2**2.0
   VAV  =  VAV/FLOAT(INUM)   -  AVE**2.0
   WRITE(4,14) EMAX2 ,  AVE  , AVAR  ,AVAM
14 FORMAT(F10.5,10X,2F10.5 ,10X , F10.5  )
   WRITE (4,31)  VMAX,  VAV
31 FORMAT  (F10.5,10X,F10.5)
   WRITE ( 9,65)  SS, WSPD , AVE , EMAX2 , AVAR , VMAX , VAV ,GTR
65 FORMAT ( 8F10.5   )
   END
```

```
BIFI PLOTS            S1367
DIMENSION COLU(100) , COLL(100) , X(2000) , Y(2000) , DATA(1024) ,
1CSS(100) ,CWS(100) , FN(100) , V(100) ,  Z(100),S(100),S1(100) ,
1  S2(100),  W(100) , CW2(100) ,  XX(2000) , ZZ(100) , FM(100) ,
1  YY(2000) , YYY(2000), YYY1(2000) , YYY2(2000), WW(100),  WWW(100
1) ,  WWW1(100) , WWW2(100) , GTR(2000)     , GTA(100) , WL(3)
1  ,XL(3)  ,  YL(3)  ,  ZL(3)  ,  XXL(3)  ,  ZZL(3)
CALL PLOTS (DATA(1),1024,0)
CALL PLOT  (0.0, 0.0 , -3 )
CALL SYMBOL(5.0 , 1.0 , 0.21 ,15HW KANABIS S1357,90.0 , 15  )
READ (3,1) NC , ND  , NS  ,EST ,NW ,ISZ  ,ISEA
1 FORMAT  (3I5  ,F5.0 ,3I5  )
READ (3,2)(CSS(I) , CWS(I) ,COLU(I) , COLL(I),CW2(I), I=1,NC)
2 FORMAT  (5F10.5)
READ (3,3)(X(I) ,XX(I), Y(I) ,YY(I) , YYY(I), YYY1(I),YYY2(I),GTR
1(I),I=  1,ND)
3 FORMAT (8F10.5)
WRITE (4,96)  XX(7)
WRITE (4,96)  XX(8)
96 FORMAT (F10.5)
DO 30  I= 1,2
CALL PLOT  (20.0, 0.0 , -3 )
Y(ND +1)  = EST
Y(ND +2)  =10.0
COLU(NC+1)= EST
COLU(NC+2)=10.0
COLL(NC+1)= EST
COLL(NC+2)=10.0
IF(I.EQ.2 )  GO TO  13
X(ND +1)  =0.0
X(ND +2)  =1.0
CSS(NC+1) = 0.0
CSS(NC+2) = 1.0
GO  TO  21
13 XX(ND +1) = 0.0
XX(ND +2) =5.0
CWS(NC  +1)  =  0.0
CWS(NC  +2)  =  5.0
CW2(NC +1)  =  0.0
CW2(NC  +2)  =  5.0
CALL LINE (XX,Y, ND, 1,-1, 5  )
DO  71  L  =  1,ND
IF  (GTR(L).LT.0.5)  GO  TO  71
XXL(1)= XX(L)
XXL(2)  =  0.0
XXL(3)  =  5.0
YL(1)= Y(L)   +1.0
YL(2)  =  EST
YL(3)  =  10.0
CALL LINE  (XXL  , YL    ,1  ,1,1,21)
71 CONTINUE
CALL LINE (CWS , COLL , NC , 1, 1, 28)
CALL LINE (CWS , COLU , NC , 1, 1, 4 )
CALL LINE (CW2 , COLL , NC , 1, 1, 15)
CALL LINE (CW2 , COLU , NC , 1, 1, 14)
GO  TO  22
21 CALL LINE (X, Y, ND, 1,-1, 5  )
DO  72  L  =  1,ND
```

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

```
      IF  (GTR(L).LT.0.5)  GO  TO  72
      XL(1)  =  X(L)
      XL(2)  =  0.0
      XL(3)  =  1.0
      YL(1)= Y(L)    +1.0
      YL(2)  =  EST
      YL(3)  =  10.0
      CALL LINE  ( XL  , YL   ,1   ,1,1,21)
   72 CONTINUE
      CALL LINE (CSS , COLL , NC , 1, 1, 28)
      CALL LINE (CSS , COLU , NC , 1, 1, 4 )
   22 CALL AXIS (0.0 ,  0.0 ,22HPROPAGATION LOSS IN DB,22,10.0,90.0,
     1Y(ND+1) , Y(ND +2) ,10.0  )
      IF(I.EQ.2 )  GO TO  15
      CALL AXIS (0.0, 0.0, 9HSEA STATE,9,12.0,0.0,X(ND+1),X(ND+2) ,10.0)
      GO  TO  23
   15 CALL AXIS (0.0,0.0,27HWIND SPEED (MILES PER HOUR),27,12.,0.,
     1 XX(ND+1),XX(ND+2),10.0  )
   23 CALL SYMBOL(2.0,9.0,0.14,18HPROPAGATION   LOSS,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      IF(I.EQ.2 )  GO TO  14
      CALL SYMBOL(2.0,8.0,0.14,18H   SEA    STATE    ,0.0,18)
      GO  TO  24
   14 CALL SYMBOL(2.0,8.0,0.14,18H  WIND    SPEED    ,0.0,18)
   24 CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      IF(I.EQ.2 )  GO TO  61
      CALL SYMBOL(1.5,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(1.5,6.75,.10,28,0.0,-1)
      IF  (ISEA.EQ.1)  GO TO 100
      CALL SYMBOL(2.0,7.0,.1,32HPREDICTION FOR NEGATIVE GRADIENT,0.0,32)
      CALL SYMBOL(2.0,6.75,.1,31HPREDICTION FOR ISOTHERMAL WATER,0.0,31)
      GO TO 104
  100 CALL SYMBOL(2.0,7.00,.1,37HLOWER PREDICTION FOR ISOTHERMAL WATER,
     1   0.0,  37)
      CALL SYMBOL(2.0,6.75,.1,37HUPPER PREDICTION FOR ISOTHERMAL WATER,
     1   0.0,  37)
  104 CALL SYMBOL   ( 1.5,6.50,.10,5,0.0,-1    )
      CALL SYMBOL   (2.0,6.50,.10,13HMEASURED LOSS,0.0,13   )
      CALL SYMBOL   ( 4.0,6.50,.1, 5,0.0,-1    )
      CALL SYMBOL   ( 4.0,6.60,.1,21,0.0,-1    )
      CALL SYMBOL   (4.50,6.50,.1,12HMINIMUM LOSS,0.0,12)
      GO  TO  69
   61 CALL   SYMBOL   ( 1.5 ,7.00, .10 ,  4, 0.0 ,-1)
      CALL   SYMBOL   ( 1.5 ,6.75, .10 , 28, 0.0 ,-1)
      CALL   SYMBOL   ( 1.5 ,6.50, .10 , 14, 0.0 ,-1)
      CALL   SYMBOL   ( 1.5 ,6.25, .10 , 15, 0.0 ,-1)
      IF  (ISEA.EQ.1)  GO TO 102
      CALL SYMBOL(2.0,7.0,.1,47HPREDICTION FOR NEGATIVE GRADIENT(REFEREN
     1CE    ),0.0,47)
      CALL SYMBOL(2.0,6.75,.1,46HPREDICTION FOR ISOTHERMAL WATER(REFEREN
     1CE    ),0.0,46 )
      CALL SYMBOL(2.0,6.5,.1,51HPREDICTION FOR NEGATIVE GRADIENT(BLOCK I
     1SLAND DATA),0.0,51)
      CALL SYMBOL(2.0,6.25,.1,50HPREDICTION FOR ISOTHERMAL WATER(BLOCK I
     1SLAND DATA),0.0,50)
      GO TO 105
  102 CALL SYMBOL(2.0,7.00,.1,52HLOWER PREDICTION FOR ISOTHERMAL WATER(R
     1EFERENCE    ), 0.0,52)
```

```
      CALL SYMBOL(2.0,6.75,.1,52HUPPER PREDICTION FOR ISOTHERMAL WATER(R
     1EFERENCE     ), 0.0,52)
      CALL SYMBOL(2.0,6.50,.1,56HLOWER PREDICTION FOR ISOTHERMAL WATER(B
     1LOCK ISLAND DATA),0.0,56)
      CALL SYMBOL(2.0,6.25,.1,56HUPPER PREDICTION FOR ISOTHERMAL WATER(B
     1LOCK ISLAND DATA),0.0,56)
  105 CALL SYMBOL  ( 1.5,7.25,.10,5,0.0,-1   )
      CALL SYMBOL  (2.0,7.25,.10,13HMEASURED LOSS,0.0,13   )
      CALL SYMBOL  ( 4.0,7.25,.1, 5,0.0,-1   )
      CALL SYMBOL  ( 4.0,7.35,.1,21,0.0,-1   )
      CALL SYMBOL  (4.50,7.25,.1,12HMINIMUM LOSS,0.0,12)
   69 IF(I.EQ.2 )  GO TO  20
      DO  7    K= 1, NS
      FN(K) = 0.0
      FM(K)  =  0.0
      V(K)  = 0.0
      WW(K)   =0.0
      WWW(K)  =  0.0
      WWW1(K)   = 0.0
      WWW2(K)   =   0.0
      GTA(K)   =  0.0
    7 W(K)  = 0.0
      GO  TO  28
   20 DO 47    K= 1, NW
      FN(K) = 0.0
      FM(K)  =  0.0
      V(K)  = 0.0
      WW(K)   =0.0
      WWW(K)  =  0.0
      WWW1(K)   = 0.0
      WWW2(K)   =   0.0
      GTA(K)   =  0.0
   47 W(K)  = 0.0
   28 DO 4  J=1,ND
      IF(I.EQ.2 )  GO TO  16
      K = 2.0*X(J)  +1.0
      WRITE  ( 4,95 )   K
      GO  TO  25
   16 XX(J)  =  XX(J)/ 5.0
      WRITE (4,96)  XX(7)
      WRITE (4,96)  XX(8)
      K =2.0*XX(J)  +1.0
      WRITE  ( 4,95 )   K
   25 IF(K.GT.3) K= K - K/3
      WRITE  ( 4,95 )   K
      IF(K.GT.6) K= K - 1
      WRITE  ( 4,95 )   K
      IF(K.GT.10)K= K - 1
      WRITE  ( 4,95 )   K
   95 FORMAT  (I5)
      FN(K) = FN(K)  + 1.0
      IF  (GTR(J).GT.0.5)   GTA(K)  =  1.0
      W(K)  = W(K) + Y(J)
      WW(K)  =  WW(K)  +  YY(J)
      V(K)  = V(K) + Y(J)**2.0
      IF   (GTR(J).GT.0.5)   GO  TO  99
      FM(K)  =  FM(K)  +  1.0
      WWW(K)  =  WWW(K)  +  YYY(J)
```

```
      WWW1(K)  =  WWW1(K)  +  YYY1(K)
      WWW2(K)  =  WWW2(K)  +  YYY2(K)
   99 WRITE  (4,11)  FN(K)  ,  W(K)  ,  V(K)  ,  K
   11 FORMAT  ( 3F10.1  ,  I10   )
    4 CONTINUE
      IF(I.EQ.2 )  GO TO  18
      READ (3,6)(Z(K) , K= 1,NS )
      GO  TO  26
   18 READ (3,6)(ZZ(K), K= 1,NW )
   26 IF(I.EQ.2 )  GO TO  17
      DO  5   K= 1, NS
      IF (FN(K).GT.0.5)  GO TO 200
      FN(K) = FN(K-1)
      W(K) = W(K-1)
      WW(K) = WW(K-1)
      Z(K) = Z(K-1)
      V(K) = V(K-1)
      GO TO   5
  200 W(K) = W(K)/FN(K)
      WW(K)  =  WW(K)/FN(K)
    5 S(K) = SQRT( V(K)/FN(K) - W(K)**2.0    )
      GO  TO  60
   17 DO 45   K= 1, NW
      IF (FN(K).GT.0.5)  GO TO 201
      FN(K) = FN(K-1)
      W(K) = W(K-1)
      WW(K) = WW(K-1)
      ZZ(K) = ZZ(K-1)
      V(K) = V(K-1)
      GO TO  45
  201 W(K) = W(K)/FN(K)
      WW(K)  =  WW(K)/FN(K)
   45 S(K) = SQRT( V(K)/FN(K) - W(K)**2.0    )
   60 CALL PLOT (20.0,0.0, -3)
    6 FORMAT(8F10.5)
      IF(I.EQ.2 )  GO TO  19
      DO    12  K = 1,  NS
      S1(K) =    W(K)  + S(K)
   12 S2(K) =    W(K)  - S(K)
      GO   TO  27
   19 DO    42  K = 1,  NW
      S1(K) =    W(K)  + S(K)
   42 S2(K) =    W(K)  - S(K)
      IF(I.EQ.2 )  GO TO  62
   27 W(NS+1)    = EST
      W(NS+2)    =10.0
      S1(NS+1)   = EST
      S1(NS+2)   =10.0
      S2(NS+1)   = EST
      S2(NS+2)   =10.0
      CSS(NC+1) = 0.0
      CSS(NC+2) = 1.0
      Z(NS+1)    = 0.0
      Z(NS+2)    = 1.0
      CALL LINE (Z,W,NS, 1,1, 5 )
      DO  81   L=  1,NS
      IF  (GTA(L).LT.0.5)  GO  TO  81
      ZL(1)= Z(L)
```

```
      ZL(2)  =  0.0
      ZL(3)  =  1.0
      WL(1)= W(L)    +1.0
      WL(2)  =  EST
      WL(3)  =  10.0
      CALL LINE  ( ZL  , WL  ,1     ,1,1,21)
   81 CONTINUE
      CALL LINE (Z,S1,NS, 1,-1, 22)
      CALL LINE (Z,S2,NS, 1,-1, 23)
      CALL LINE (CSS,COLU,NC, 1, 1, 4 )
      CALL LINE (CSS,COLL,NC, 1, 1, 28)
      CALL AXIS (0.0, 0.0, 9HSEA STATE,9,12.0,0.0,X(ND+1),X(ND+2) ,10.0)
      CALL AXIS (0.0 ,  0.0 ,22HPROPAGATION LOSS IN DB,22,10.0,90.0,
     1Y(ND+1) , Y(ND +2) ,10.0  )
      CALL SYMBOL(2.0,9.0,0.14,18HPROPAGATION   LOSS,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H   SEA     STATE    ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(1.5,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(1.5,6.75,.10,28,0.0,-1)
      IF   (ISEA.EQ.1)  GO TO 101
      CALL SYMBOL(2.0,7.0,.1,32HPREDICTION FOR NEGATIVE GRADIANT,0.0,32)
      CALL SYMBOL(2.0,6.75,.1,31HPREDICTION FOR ISOTHERMAL WATER,0.0,31)
      GO TO 106
  101 CALL SYMBOL(2.0,7.00,.1,37HLOWER PREDICTION FOR ISOTHERMAL WATER,
     1   0.0,  37)
      CALL SYMBOL(2.0,6.75,.1,37HUPPER PREDICTION FOR ISOTHERMAL WATER,
     1   0.0,  37)
  106 CALL SYMBOL (1.5,6.50,.10,5,0.0,-1)
      CALL SYMBOL (2.0,6.50,.10,14HAVERAGE VALUES,        0.0,14)
      CALL SYMBOL  ( 4.0,6.50,.1, 5,0.0,-1    )
      CALL SYMBOL  ( 4.0,6.60,.1,21,0.0,-1    )
      CALL SYMBOL  (4.50,6.50,.1,12HMINIMUM LOSS,0.0,12)
      CALL SYMBOL (1.5,6.25,.10,22,0.0,-1)
      CALL SYMBOL (2.0,6.25,.10,24HUPPER STANDARD DEVIATION,0.0,24)
      CALL SYMBOL (1.5,6.00,.10,23,0.0,-1)
      CALL SYMBOL (2.0,6.00,.10,24HLOWER STANDARD DEVIATION,0.0,24)
      WRITE (4,10)
   10 FORMAT ( 50H SEA STATE AVER LOSS NUM VALVES STANDARD DEVIATION)
      DO 8 M= 1,NS
    9 FORMAT (4F10.5)
    8 WRITE (4,9) Z(M) , W(M), FN(M) , S(M)
      IF   (ISZ.EQ.1)    GO   TO   30
      WW(NS +1)  =  EST
      WW(NS +2)  =  10.0
      WWW(NS +1)  =  0.0
      WWW(NS +2)  =  10.0
      WWW1(NS +1)  =  0.0
      WWW1(NS +2) =  5.0
      WWW2(NS +1)  =  0.0
      WWW2(NS +2) =  5.0
      CALL PLOT  (20.0, 0.0 , -3 )
      CALL  LINE  (Z ,     W,  NS,  1  ,1  ,  5 )
      CALL  LINE  (Z ,    WW,  NS,  1  ,1  ,  4 )
      DO  82   L=  1,NS
      IF   (GTA(L).LT.0.5)  GO  TO 82
      ZL(1)= Z(L)
      ZL(2)  =  0.0
```

```
      ZL(3)  =  1.0
      WL(1)= W(L)    +1.0
      WL(2)  =  EST
      WL(3)  =  10.0
      CALL LINE  ( ZL  , WL   ,1   ,1,1,21)
   82 CONTINUE
      CALL AXIS (0.0 ,  0.0 ,22HPROPAGATION LOSS IN DB,22,10.0,90.0,
     1Y(ND+1) , Y(ND +2) ,10.0  )
      CALL AXIS (0.0, 0.0, 9HSEA STATE,9,12.0,0.0,X(ND+1),X(ND+2) ,10.0)
      CALL SYMBOL(2.0,9.0,0.14,18HPROPAGATION   LOSS,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H   SEA     STATE   ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(2.0,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(2.5,7.0,.1,32HMAXIMUM OVER PULSE               ,0.0,32)
      CALL SYMBOL(2.0,6.75,.10, 5,0.0,-1)
      CALL SYMBOL(2.5,6.75,.1,31HAVERAGE OVER PULSE              ,0.0,31)
      CALL SYMBOL  (4.75,6.75,.1, 5,0.0,-1   )
      CALL SYMBOL  (4.75,6.85,.1,21,0.0,-1   )
      CALL SYMBOL  (5.00,6.75,.1,12HMINIMUM LOSS,0.0,12)
      CALL PLOT  (20.0, 0.0 , -3 )
      DO 205  K= 1,NS
      IF (FM(K).GT.0.5)  GO TO 202
      WWW(K) = WWW(K-1)
      WWW1(K) = WWW1(K-1)
      WWW2(K) = WWW2(K-1)
      Z(K) = Z(K-1)
      GO TO 205
  202 WWW(K)  =  WWW(K)/FM(K)
      WWW1(K)  =  WWW1(K)/FM(K)
      WWW2(K)  =  WWW2(K)/FM(K)
  205 CONTINUE
      CALL  LINE  (Z ,  WWW,  NS,  1  ,1  ,  4 )
      CALL AXIS (0.0,0.0, 8HVARIANCE,8,10.,90.,WWW(NS+1),WWW(NS+2),10.0)
      CALL AXIS (0.0, 0.0, 9HSEA STATE,9,12.0,0.0,X(ND+1),X(ND+2) ,10.0)
      CALL SYMBOL(2.0,9.0,0.14,18H    VARIANCE      ,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H   SEA     STATE   ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(2.0,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(2.5,7.0,.1,32HVARIANCE OVER PULSE              ,0.0,32)
      CALL PLOT  (20.0, 0.0 , -3 )
      CALL  LINE  (Z , WWW1,  NS,  1  ,1  ,  5 )
      CALL  LINE  (Z , WWW2,  NS,  1  ,1  ,  4 )
      CALL AXIS (0.0,0.0, 8HVARIANCE,8,10.,90.,WWW(NS+1),WWW(NS+2),10.0)
      CALL AXIS (0.0, 0.0, 9HSEA STATE,9,12.0,0.0,X(ND+1),X(ND+2) ,10.0)
      CALL SYMBOL(2.0,9.0,0.14,18H    VARIANCE      ,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H   SEA     STATE   ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(2.0,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(2.5,7.0,.1,32HVARIANCE OF AVERAGE OVER PULSE  ,0.0,32)
      CALL SYMBOL(2.0,6.75,.10, 5,0.0,-1)
      CALL SYMBOL(2.5,6.75,.1,31HVARIANCE OF MAXIMUM OVER PULSE ,0.0,31)
      GO TO 30
   62 ZZ(NW + 1)  =  0.0
      ZZ(NW + 2)  =  5.0
      W(NW  +1)   =   EST
```

```
      W(NW   +2)  =   10.0
      S1(NW   +1)  =  EST
      S1(NW   +2)  =  10.0
      S2(NW   +1)  =  EST
      S2(NW   +2)  =  10.0
      CWS(NC   +1)  =  0.0
      CWS(NC   +2)  =  5.0
      CW2(NC +1)  =  0.0
      CW2(NC   +2)  =  5.0
      CALL  LINE  (ZZ ,W ,NW , 1,1,5)
      DO  83   L=  1,NW
      IF  (GTA(L).LT.0.5)  GO  TO  83
      ZZL(1)= ZZ(L)
      ZZL(2)  =  0.0
      ZZL(3)  =  5.0
      WL(1)= W(L)    +1.0
      WL(2)  =  EST
      WL(3)  =  10.0
      CALL LINE  (ZZL  , WL   ,1   ,1,1,21)
   83 CONTINUE
      CALL  LINE  (ZZ ,S1 , NW ,1,-1,22)
      CALL  LINE  (ZZ ,S2 , NW ,1,-1,23)
      CALL  LINE  (CWS , COLU , NC ,1,1,4)
      CALL  LINE  (CWS , COLL , NC ,1,1,28)
      CALL  LINE  (CW2 , COLU , NC ,1,1,14)
      CALL  LINE  (CW2 , COLL , NC ,1,1,15)
      CALL AXIS (0.0,0.0,27HWIND SPEED (MILES PER HOUR),27,12.,0.,
     1 XX(ND+1),XX(ND+2),10.0  )
      CALL AXIS (0.0 ,  0.0 ,22HPROPAGATION LOSS IN DB,22,10.0,90.0,
     1Y(ND+1) , Y(ND +2) ,10.0   )
      CALL SYMBOL(2.0,9.0,0.14,18HPROPAGATION   LOSS,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H  WIND    SPEED   ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL   SYMBOL  ( 1.5 ,7.00, .10 ,  4, 0.0 ,-1)
      CALL   SYMBOL  ( 1.5 ,6.75, .10 , 28, 0.0 ,-1)
      CALL   SYMBOL  ( 1.5 ,6.50, .10 , 14, 0.0 ,-1)
      CALL   SYMBOL  ( 1.5 ,6.25, .10 , 15, 0.0 ,-1)
      IF  (ISEA.EQ.1)  GO TO 103
      CALL SYMBOL(2.0,7.0,.1,47HPREDICTION FOR NEGATIVE GRADIENT(REFEREN
     1CE    ),0.0,47)
      CALL SYMBOL(2.0,6.75,.1,46HPREDICTION FOR ISOTHERMAL WATER(REFEREN
     1CE    ),0.0,46 )
      CALL SYMBOL(2.0,6.5,.1,51HPREDICTION FOR NEGATIVE GRADIENT(BLOCK I
     1SLAND DATA),0.0,51)
      CALL SYMBOL(2.0,6.25,.1,50HPREDICTION FOR ISOTHERMAL WATER(BLOCK I
     1SLAND DATA),0.0,50)
      GO TO 107
  103 CALL SYMBOL(2.0,7.00,.1,52HLOWER PREDICTION FOR ISOTHERMAL WATER(R
     1EFERENCE     ), 0.0,52)
      CALL SYMBOL(2.0,6.75,.1,52HUPPER PREDICTION FOR ISOTHERMAL WATER(R
     1EFERENCE     ), 0.0,52)
      CALL SYMBOL(2.0,6.50,.1,56HLOWER PREDICTION FOR ISOTHERMAL WATER(B
     1LOCK ISLAND DATA),0.0,56)
      CALL SYMBOL(2.0,6.25,.1,56HUPPER PREDICTION FOR ISOTHERMAL WATER(B
     1LOCK ISLAND DATA),0.0,56)
  107 CALL SYMBOL (1.5,6.00,.10,23,0.0,-1)
      CALL SYMBOL (2.0,6.00,.10,24HLOWER STANDARD DEVIATION,0.0,24)
```

```
      CALL SYMBOL (1.5,5.75,.10,22,0.0,-1)
      CALL SYMBOL (2.0,5.75,.10,24HUPPER STANDARD DEVIATION,0.0,24)
      CALL SYMBOL (1.5,5.50,.10,5,0.0,-1)
      CALL SYMBOL (2.0,5.50,.10,14HAVERAGE VALUES,       0.0,14)
      CALL SYMBOL  (4,25,5.55,.1, 5,0.0,-1    )
      CALL SYMBOL  (4,25,5.65,.1,21,0.0,-1    )
      CALL SYMBOL  (4.50,5.55,.1,12HMINIMUM LOSS,0.0,12)
      WRITE (4,90)
   90 FORMAT ( 50H WIND SPEEDAVER LOSS NUM VALVES STANDARD DEVIATION)
      DO 80M= 1,NW
   80 WRITE (4,9)ZZ(M) , W(M), FN(M) , S(M)
      IF  (ISZ.EQ.1)   GO  TO  30
      WW(NW +1)  =  EST
      WW(NW +2)  =  10.0
      WWW(NW +1)  =  0.0
      WWW(NW +2)  =  10.0
      WWW1(NW +1)  =  0.0
      WWW1(NW +2) =  5.0
      WWW2(NW +1)  =  0.0
      WWW2(NW +2) =  5.0
      CALL PLOT  (20.0, 0.0 , -3 )
      CALL  LINE  (ZZ,    W,   NW,  1  ,1  ,  5 )
      CALL  LINE  (ZZ,    WW,  NW,  1  ,1  ,  4 )
      DO  84   L=  1,NW
      IF  (GTA(L).LT.0.5)  GO  TO  84
      ZZL(1)= ZZ(L)
      ZZL(2)  =  0.0
      ZZL(3)  =  5.0
      WL(1)= W(L)   +1.0
      WL(2)  =  EST
      WL(3)  =  10.0
      CALL LINE  (ZZL  , WL   ,1   ,1,1,21)
   84 CONTINUE
      CALL AXIS (0.0 ,  0.0 ,22HPROPAGATION LOSS IN DB,22,10.0,90.0,
     1Y(ND+1) , Y(ND +2) ,10.0  )
      CALL AXIS (0.0,0.0,27HWIND SPEED (MILES PER HOUR),27,12.,0.,
     1 XX(ND+1),XX(ND+2),10.0  )
      CALL SYMBOL(2.0,9.0,0.14,18HPROPAGATION   LOSS,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H  WIND    SPEED   ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(2.0,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(2.5,7.0,.1,32HMAXIMUM OVER PULSE               ,0.0,32)
      CALL SYMBOL(2.0,6.75,.10, 5,0.0,-1)
      CALL SYMBOL(2.5,6.75,.1,31HAVERAGE OVER PULSE              ,0.0,31)
      CALL SYMBOL  ( 4.5,6.75,.1, 5,0.0,-1    )
      CALL SYMBOL  ( 4.5,6.85,.1,21,0.0,-1    )
      CALL SYMBOL  (5.00,6.75,.1,12HMINIMUM LOSS,0.0,12)
      CALL PLOT  (20.0, 0.0 , -3 )
      DO 245  K= 1,NW
      IF (FM(K).GT.0.5)  GO TO 203
      WWW(K) = WWW(K-1)
      WWW1(K) = WWW1(K-1)
      WWW2(K) = WWW2(K-1)
      ZZ(K) = ZZ(K-1)
      GO TO 245
  203 WWW(K)  =  WWW(K)/FM(K)
      WWW1(K)  =  WWW1(K)/FM(K)
```

```
      WWW2(K)  =  WWW2(K)/FM(K)
  245 CONTINUE
      CALL  LINE  (ZZ,  WWW,  NW,  1  ,1  ,  4 )
      CALL AXIS (0.0,0.0,8HVARIANCE,8,10.,90.,WWW1(NW+1),WWW1(NW+2),10.)
      CALL AXIS (0.0,0.0,27HWIND SPEED (MILES PER HOUR),27,12.,0.,
     1 XX(ND+1),XX(ND+2),10.0  )
      CALL SYMBOL(2.0,9.0,0.14,18H    VARIANCE       ,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H  WIND    SPEED    ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(2.0,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(2.5,7.0,.1,32HVARIANCE OVER PULSE                ,0.0,32)
      CALL PLOT  (20.0, 0.0 , -3 )
      CALL  LINE  (ZZ, WWW1,  NW,  1  ,1  ,  5 )
      CALL  LINE  (ZZ, WWW2,  NW,  1  ,1  ,  4 )
      CALL AXIS (0.0,0.0,8HVARIANCE,8,10.,90.,WWW1(NW+1),WWW1(NW+2),10.)
      CALL AXIS (0.0,0.0,27HWIND SPEED (MILES PER HOUR),27,12.,0.,
     1 XX(ND+1),XX(ND+2),10.0  )
      CALL SYMBOL(2.0,9.0,0.14,18H    VARIANCE       ,0.0,18)
      CALL SYMBOL(3.0,8.5,0.10, 6HVERSUS,0.0,6 )
      CALL SYMBOL(2.0,8.0,0.14,18H  WIND    SPEED    ,0.0,18)
      CALL SYMBOL(2.0,7.5,0.14,18HFREQUENCY  1700 HZ,0.0,18 )
      CALL SYMBOL(2.0,7.00,.10 ,4,0.0,-1)
      CALL SYMBOL(2.5,7.0,.1,32HVARIANCE OF AVERAGE OVER PULSE  ,0.0,32)
      CALL SYMBOL(2.0,6.75,.10, 5,0.0,-1)
      CALL SYMBOL(2.5,6.75,.1,31HVARIANCE OF MAXIMUM OVER PULSE ,0.0,31)
   30 CONTINUE
      CALL PLOT (20.0,0.0, -3)
      CALL PLOT (0.0,0.0,900)
      END
```